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Appendix P
INTERIM REPORT ON EMERGENCY COMMUNICATIONS

P.1 INTRODUCTION

On September 11, 2001, radio and telephone communications played a significant role in the operations of emergency responders at the World Trade Center (WTC). Radio and telephone communications were a primary means of communicating information to emergency responders concerning the incident. These forms of communication were also used by emergency responders to communicate with people trapped in the WTC buildings and people attempting to evacuate from the buildings. They were used to communicate between members of the same emergency responder departments for planning and operations at the incident, and they were used to communicate between different departments or responding organizations at the incident.

Each of the governmental departments that had emergency responders at the WTC—New York City Fire Department (FDNY), New York City Police Department (NYPD), and the Port Authority Police Department (PAPD)—depended on their ability to communicate to accomplish their mission and to obtain information related to operations safety at the incident. Personnel from each of the departments used radios, cellular phones, and wired or landline telephones for communications during the incident. In addition, the emergency responders relied on the most basic form of communication, direct face-to-face communications.

As a normal practice during a typical emergency response many radio and telephone communications are recorded by the respective departments that respond to an incident. These recordings are normally made by the departments to provide an accurate record of operations during an incident. These records are often used by departments during review of incident operations. They are also used for investigative purposes and are sometimes used as evidence in legal cases. During the attack on the WTC many of the emergency responder communications were recorded and preserved. This study is based on these recordings. In addition, information gathered by personnel from the National Institute of Standards and Technology (NIST) during first-person interviews with more than 100 emergency responders has contributed to the report.

P.2 REPORT OBJECTIVES

The objective of this study is to develop a better understanding of the role that emergency communications played during the attack on the WTC, and to quantify information related to communications effectiveness. Although there have been numerous reports of radio equipment failures during the emergency response at the WTC, the only radio system examined in this study is that of the FDNY WTC site high-rise repeater that was installed by the Port Authority. This report does not address issues related to the technical capabilities of any other radio equipment. The analysis of handie-talkies and other radio equipment is in progress and will be addressed in a following report.

Many factors are associated with the ability of emergency communications to be successful. The following objectives were set in this report:

- To document radio and telephone communications operations
- To document radio communications readability or understandability
- To quantifying radio communications traffic volume
- To understand the impact of traffic volume on communications readability and the transfer of information
- To identify communications associated with dispatch and arrival of responders
- To identify communications related to evacuation and emergency response operations
- To identity communications related to building conditions at the WTC and the impact of this information on the emergency response

P.3 RADIO AND TELEPHONE COMMUNICATIONS

Both the Port Authority of New York and New Jersey (PANYNJ) and the NYPD supplied copies of audio recordings from the emergency response operations at the WTC. The PANYNJ provided digital copies of the audio communications tapes recorded by them during the incident. These recordings included communications from emergency response personnel, maintenance personnel, PAPD personnel, and a recording of the FDNY's Channel 30 radio repeater that was located at the WTC. Channel 30 was a City-wide channel designated by FDNY for use in high-rise building operations. The Port Authority had installed this radio repeater system at the WTC for use by FDNY after the 1993 bombing.

The NYPD submitted their communications to NIST in the form of audio tapes that were copies of the original tapes recorded on September 11, 2001. These tapes included radio communications from NYPD internal department operations.

FDNY communications recordings were not available from the incident location that day because the primary Field Communications truck was in the shop for repairs and a backup Field Communications van was used in its place. The backup Field Communications van did not have the capability to record the on-scene incident command or tactical communications; also, the backup van was destroyed when the towers collapsed. Therefore, the best record of radio communications available to NIST on FDNY operations came from the FDNY/PAPD Channel 30 tape and first-person accounts provided by FDNY personnel during their interviews. The Channel 30 tape provides a limited amount of information on FDNY communications and operations at the incident, but it does provide insight into FDNY operations inside WTC 2.

Each audio communications file was received from the source with the starting and ending times marked on the media jacket or the surface of the media. A list of all communications recordings acquired from the various departments is found in Attachment 1 at the end of the report.

P.3.1 Telephone Communications Recordings

Because telephone communication (both landline and cellular phone) was a contributing part of the emergency communications process during the incident, NIST received copies of telephone emergency response communications from the PANYNJ. Identification information for these recordings is also listed in Attachment 1. The City of New York provided NIST with opportunities to review their telephone recordings for 9-1-1 Emergency Operators and FDNY fire dispatchers in their New York City offices. At this time, the telephone recordings have been reviewed and documented, and the analysis work is still in progress. A detailed analysis of emergency telephone communications will be covered in a following report.

P.3.2 First-Person Accounts of Telephone Communications

As mentioned earlier, more than 100 first-person interviews were conducted with emergency responders that reported to the WTC incident. The following information was drawn from these interviews:

- Before the attack occurred on the WTC both the landline and cellular systems appeared to be working normally.
- Only moments after the first aircraft impacted WTC 1, the landline and cellular telephone systems were stressed by increased caller volume that made it difficult to get messages through. This condition continued for many hours following the attack.
- Telephone calls from the WTC to the 9-1-1 emergency operators and statements from various individuals being interviewed shows that even though WTC 1 and WTC 2 were severely damaged by the aircraft impact and fires, many of the landline telephones in the buildings continued to work up until the collapse of WTC 2.
- After the collapse of WTC 2, a number of cellular phone systems were not functional in the area of lower Manhattan.
- After the collapse of WTC 2, there were still some landline telephones working within the city block areas adjacent to the WTC site.

P.4 COMMUNICATIONS FILES PROCESSING AND PRELIMINARY EVALUATION

P.4.1 Audio Data Files and Processing

An evaluation of methods for listening to the recorded communications files was carried out. Comparisons were made between the functionality of using tape recorders versus that of using digital computer-based software for listening to the various emergency response communications files. It became apparent that the computer based listening system had advantages over the use of tape recorders. Some of the advantages of the computer based system are the ease of operation, ability to use the computer monitor for visually observing the beginning and end of communications periods, and the ability to easily and accurately reverse through a recording to a selected location so that a selected section

of a communication could be listened to multiple times. As a result, it was decided to conduct the audio communications study using the computer based audio software system. This decision had a direct impact on the type of data format and media that would be needed for conducting the audio communications study. Therefore, NIST requested that audio communications be provided in a digital format on CD-ROM disks.

The communications recordings provided by the PANYNJ were digital files that were copied onto CD-ROMs, and they were in a format that could be played by computers while using audio player computer software. The audio recordings on each of the NYPD cassettes had to be converted to a digital format, and each file was then recorded onto a CD-ROM disk. In addition, some of the recordings that were received were recorded at very low amplitude that made it difficult to hear the communications. NIST used professional-quality computer audio software to increase the low audio volume recordings to a usable audio level.

P.4.2 Audio Data Computer Software

Three different types of software were used while conducting communications analysis on the audio recordings. Each of these software packages incorporated a clock for timing the audio recording and important communications during the incident.

The first, Sound Forge 6.0, a product of Sonic Foundry, Inc., of Madison, Wisconsin, is a professional digital audio editor (Sonic 2002). It possesses tools that can assist with increasing audio quality and volume of digital audio recordings. It has a graphic output to the computer monitor that allows for rapid evaluation of large audio files. It is also capable of operating as a tool for spectrum analysis. As a spectrum analyzer, it can be used to analyze waveforms by frequency, and it helps to identify noise problems in communications data. In addition, the audio waveforms can be expanded on various scales for detailed analysis. This software was used throughout the study for analysis of the recordings that required audio adjustments to improve quality.

The other two software packages were used as general purpose audio players. They both possess the same basic capabilities and were applied in this audio analysis process based on user preference.

Windows Media Player, a digital media player software package, is a product of Microsoft, Inc. (Microsoft 2003). This media player can be downloaded from the Internet. The player allows for viewing of audio wave forms from the digital audio files that are being listened to. It allows for easily changing a computer's audio volume, and it may be used effectively for locating specific points on an audio recording. The software also allows for movement through an audio file in a reverse direction so that selections of an audio file can be listened to multiple times.

WinAmp3 is a media playback software package for Windows that can be downloaded from the Internet, and it is a product of Nullsoft, Inc. (Nullsoft 2002). This player allows for viewing of audio wave forms from the digital audio files that are being listened to. It allows for easily changing a computers audio volume and it may be used effectively for locating specific points on an audio recording. The software also allows for movement through an audio file in a reverse direction so that selections of an audio file can be listened to multiple times.

P.5 ANALYSIS OF AUDIO COMMUNICATIONS FILES

Analysis of the communications recordings was a multistep process that began with sorting and cataloging the files. The initial sort separated radio communications files from telephone communications files. The files were also cataloged as it related to emergency response operations: PANYNJ, PAPD, FDNY, and NYPD. The respective files were then checked for content and primary emergency response channel files were selected for analysis first. Primary emergency response channels were channels specifically used by PAPD, NYPD, and FDNY for conducting emergency response operations at the WTC. The secondary channels relate to maintenance channels and other emergency responder channels that were not directly associated with operations at the WTC.

Analysis was carried out using the computer based software media players described above. The professional quality digital audio software, Sound Forge 6.0, was used for listening to and enhancing audio files that were difficult to hear. The two other media player software packages, Windows Media Player and WinAmp3, were used to listen to the majority of audio recordings.

P.5.1 Communications Transcription

Two different processes were used to transcribe the emergency communications. Data for the primary emergency communications files were put into a spreadsheet format so that a detailed analysis of results could be made. The overall analysis work is continuing; however, some of the data put into the spreadsheets was used to assist in quantifying communications quality and the radio traffic volume as related to time, as will be discussed in Section P.7. The second and simplest form of communications transcription was the verbatim transcription of the communications into a word processor data file, which was used to record the secondary communications files.

The primary communications audio files were selected for complete transcription to generate information concerning the quality of communications. The files selected were the FDNY Channel 7/PAPD Channel 30 radio repeater, the PAPD police desk radio channel, and the NYPD Special Operations Division channel and Division 1. These files included the following:

- Time of the radio transmission (radio transmission time was taken from the media player clock and was adjusted for the start time supplied with the communications file.)
- Type of radio transmission (voice or tone only for primary emergency response communications channels)
- Readability signal quality (done only for the primary emergency response communications radio channels)
- Content of the communication

As the communications transcripts were being prepared, the names of individuals identified during the communications were deleted to protect the identity of individuals and to adhere to the confidentiality agreements with the various organizations that supplied the communications data files.

P.5.2 Transcription Methods

As mentioned earlier, the communications transcripts were generated using three different computer based media players. The media players were installed on computer systems that were stand alone and isolated from the internet. The process for preparing a communications transcript was the following:

- The communications data file was loaded onto the computer.
- The media player was opened and the data file was selected.
- The spreadsheet on the computer was opened and prepared for data input.
- The transcriber would queue the communications recording to the beginning and check to be sure that the media player clock time was zeroed.
- The data file starting time was put into the spreadsheet.
- The communications recording was started, and the output was written into the spreadsheet.
- To improve accuracy of the transcripts, a second transcriber checked sections of the transcript against the audio recording.

For audio passages that were difficult to understand on the first pass, multiple passes of the section were used to improve comprehension.

P.5.3 Assessment of Radio Communications Quality

The Readability, Signal Strength, and Tone system for rating the quality of radio communications is used widely throughout the field of radio communications and is described in *The ARRL Handbook for Radio Communications* (ARRL 2003). This system is broken into three distinctive groups that can be rated: Readability, Signal Strength, and Tone. The rating for tone is only used to identify the quality of radio communications for "Continuous Wave" transmissions, and it does not apply to this analysis as "Tone" does not relate to voice communications. For voice radio communications, only "Readability" and "Signal Strength" are used. Signal Strength" is usually read from a signal strength meter at the time of the actual radio communication and is not available on the audio recordings.

Thus, in this study "Readability" only was used for rating the primary emergency responder radio communications channel recordings. It is recognized that this form of analysis is subjective, and it relates to the ability of an individual to hear and understand the radio communications. In an attempt to minimize the influence of the subjective rating system, individuals with extensive experience using radio communications and project staff trained by the experienced personnel were used to conduct the analysis. In addition, communication periods from the various recorded data sets were reviewed by more than one

person where radio communications readability was difficult. The rating table for communications readability is listed below (ARRL 2003):

Readability (the term "readable" means "understandable")**:**
1 – Unreadable2 – Barely readable, occasional words distinguishable
3 – Readable with considerable difficulty
4 – Readable with practically no difficulty
5 – Perfectly readable

P.5.4 Training of Transcribers

Four NIST personnel were used to transcribe the emergency responder communications files. This included the Project Leader and three other staff personnel. The transcription protocol listed above was planned and tested by the two senior NIST personnel, including the project leader. When the protocol was found to be acceptable, the two other NIST personnel were trained by the senior members of the group. After the basic transcription training was completed, each of the new transcribers was given a communications file to transcribe. This communications file had previously been transcribed by the two senior personnel. After the file was transcribed by the new transcriber, their results were compared to that transcribed by the senior personnel. When it was demonstrated that the new transcriber had a full understanding of the transcription process, they were then assigned communications files to transcribe.

P.6 RADIO COMMUNICATIONS CONCEPTS

Currently, for most emergency responder radio systems the only way to produce a totally clear communication that can be received and understood is for only one communications signal to be transmitted at a time on a given radio frequency. This means that only one person can transmit a radio message at a time without creating communications interference on that radio frequency. With these systems, if two or more radio transmissions are made on the same radio frequency at the same time, signal mixing may occur and the communications may not be understandable. This difficulty with radio communications is often referred to as doubling. Under these conditions, usually the radio with the highest transmitting power will override transmissions from the lower-power radios and only the highest-power radio signal will be heard. This is often the case where an emergency response radio system uses a higher-power base station for dispatch communications or where a repeater is used to amplify a radio system's signal output. Where multiple radio communications are received by a radio repeater, signal mixing is likely to occur and the communications will not be understandable (ARRL 2003).

Over the last several years radio communications technology has undergone some significant advancements, particularly with cellular phones. These new systems can increase the effective use of the radio frequency/time factors related to radio communications (ARRL 2003), and are now beginning to be applied to emergency responder communications equipment.

P.7 COMMUNICATIONS DATA ANALYSIS

This analysis of communications addresses five major factors: (1) radio traffic volume, (2) communications duty cycle, (3) readability of communications, (4) operation of the FDNY site high-

rise repeater at the WTC, and (5) the development of a chronology of radio communications from the incident.

The first two factors, radio traffic volume and communications duty cycle, are directly related, and each has an impact on readability, the ability to understand and also deal with the information being communicated. Generally, as radio traffic rate increases, the operations duty cycle approaches overloaded conditions. With very high traffic volumes it becomes more difficult for personnel at central communications facilities and personnel in the field to respond to the volume of traffic. Human operators of communications equipment become overloaded with work because not only do the operators have to verbally communicate with personnel over the radio, but they must often transfer the information gained to other locations. The transfer of information may also be done verbally using other communications systems or it may be done by hand through keyboard inputs or by both methods. Analysis of the radio traffic for each of the departments shows periods where radio traffic rates during the surge conditions potentially resulted in situations where base station radio operators were unable to relay important information.

P.7.1 PAPD Radio Communications

All radio communications evaluated for this report experienced traffic volume surge conditions as a result of the attack. The traffic volume surge greatly exceeded the traffic volume experienced under normal operating conditions.

PAPD Channel 26/W is used to demonstrate typical radio communications and operations conditions that occurred with the PAPD before and during the incident. This radio channel is used by PAPD police officers, NYPD supervisors and FDNY Engine 10 and Ladder 10 for communications at the WTC site. Tables P–1 and P–2 compare the number of transmissions and their length of time before and after the first aircraft impacted WTC 1. The percent of radio transmissions versus time are also shown on Fig. P–1. This percent of radio transmission, as well as others discussed in this report, was calculated based on the sum of transmission time and no transmission time over a given period of time. These data show that there was a 13 percent rate of radio transmissions on the PAPD police desk channel just prior to the aircraft impact. After the first aircraft impact on WTC 1 the radio communications were occurring 87 percent of the time. This surge in communications significantly impacted the functional capability of the radio system. After approximately 10 minutes, communications dropped to a steady operating level of 48 percent capacity.

P.7.2 FDNY Radio Communications

The communications for this FDNY, City-wide, high-rise building, radio Channel 7 was recorded by PAPD on their Channel 30. The Port Authority installed this high-rise repeater at the WTC for FDNY following the 1993 bombing. This FDNY channel was used primarily by FDNY personnel during operations in WTC 2. Personnel using this channel were FDNY Chief Officers, Company Officers, Aides, and firefighters.

Table P–1. Comparison of radio transmissions before and after the first aircraft impact.

Department	Number of transmissions before first aircraft impact (20 min period)	Number of transmissions after first aircraft impact (20 min period)
PAPD	42	176
FDNY	39	134
NYPD Division 1	7[a]	225
NYPD Special Operations Division	No data	192

a. Data only available for 2 min prior to first aircraft impact

Table P–2. Comparison of average and maximum radio transmission times before and after first aircraft impact.

Department	Average time per transmission before first aircraft impact and maximum (s)	Average time per transmission after first aircraft impact and maximum (s)
PAPD	3.8 (maximum 21.8)	3.3 (maximum 19.7)
FDNY	3.8 (maximum 50.9)	3.1 (maximum 19.5)
NYPD Division 1	1.9 (maximum 5.9)	3.4 (maximum 12.6)
NYPD Special Operations Division	No data	5.7 (maximum 31.5)

Note: All minimum transmission times were typically less than 1 s and were often related to the keying of a microphone.

While looking at these data it is important to keep in mind that several FDNY personnel at the incident did not think that the WTC site, high-rise channel, radio repeater was working. This is based on radio communications tests that were conducted by two Chief Officers working inside WTC 1 when the first Command Post was being set up in that lobby. A record of this radio communications test was recorded on the PAPD Channel 30 tape. Following this radio test, a Chief Officer involved in the test chose to use different channels for command and tactical communications during the incident. However, as FDNY operations increased in WTC 2, it was determined by members of the FDNY that the high-rise channel was functioning and use of the channel developed.

Preliminary analysis by NIST indicates that the repeater was operating at the WTC; however, there also appears to be some type of malfunction with the communications equipment. This malfunction was detected by the FDNY officers during the initial communications test, but it was not identified. As a result, this radio frequency was not primarily being used by many emergency responders. Two hypotheses are currently being studied related to the malfunction: (1) damage to the repeater antenna system and (2) failure of the radio hand set located at the Fire Command Desk in the lobby of WTC 1. Two failure modes are being considered, (1) the radio handset was broken, and (2) the volume on the handset was turned down. The evaluation of the repeater and its operation is still under way, and final

conclusions have not yet been drawn concerning the repeater's performance. Additional information will be covered in the WTC Investigation final report.

Traffic load for this FDNY channel is summarized in Tables P–1 and P–2 and in Fig. P–2. Figures P–1 and P–2 shows that there was a significant peak in radio traffic that approached an 80 percent level which then dropped to a near steady high level of operations several minutes following the aircraft impact. The communications traffic level following the aircraft impact was four times greater than the level prior to impact.

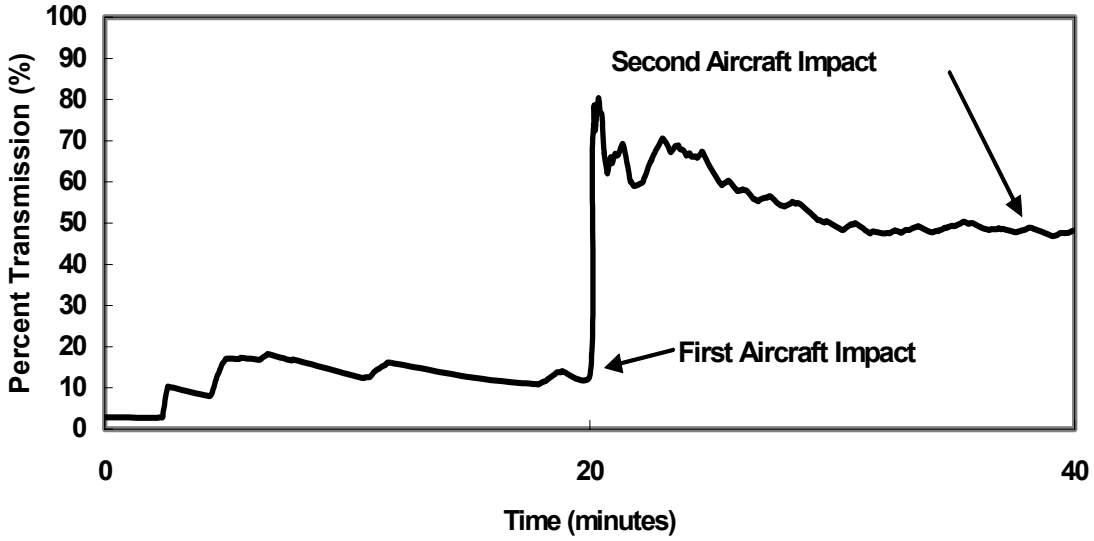


Figure P–1. PAPD police desk Channel 26/W plot of percent transmission versus time.

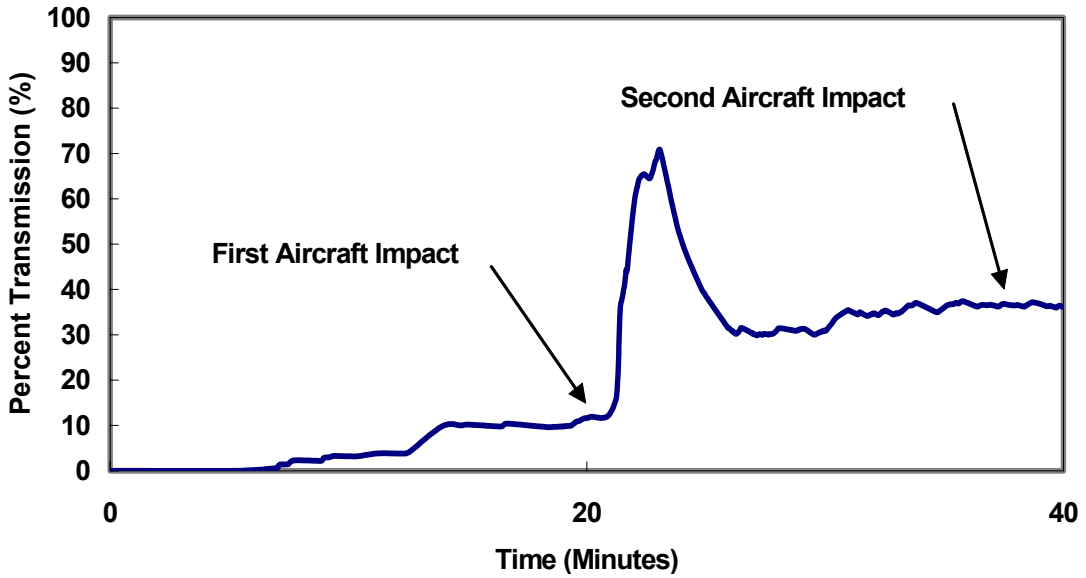


Figure P–2. FDNY City-wide high-rise Channel 7 (PAPD Channel 30) plot of percent transmission versus time.

P.7.3 NYPD Radio Communications

The third example illustrates radio communications for the NYPD Division 1 channel and the NYPD Special Operations Division channel. The Division 1 channel was used by police officers and supervisory police officers. The Special Operations Division channel was used by senior level NPYD management, supervisory police officers, Emergency Service Unit personnel, and aviation unit personnel.

The communications recordings provided by NYPD did not typically contain communications that preceded the attack. However, the Division 1 radio channel recording did start approximately 2 minutes before the first aircraft impacted WTC 1. This 2 minute period provides a limited sample of the level of radio communications prior to the attack. The volume of NYPD communications is shown in Tables P–1 and P–2. These data demonstrate that NYPD had a similar surge in radio traffic immediately following the attack. Figure P–3 shows that the level of transmissions before the attack was at approximately 15 percent. Following the attack the level of transmissions jumped to over 90 percent and then settled down to a level of 63 percent. Radio traffic on the Special Operations Division channel was even higher, as shown in Fig. P–4, peaking near the 95 percent level and staying in the 80 percent range over the remainder of the sample period.

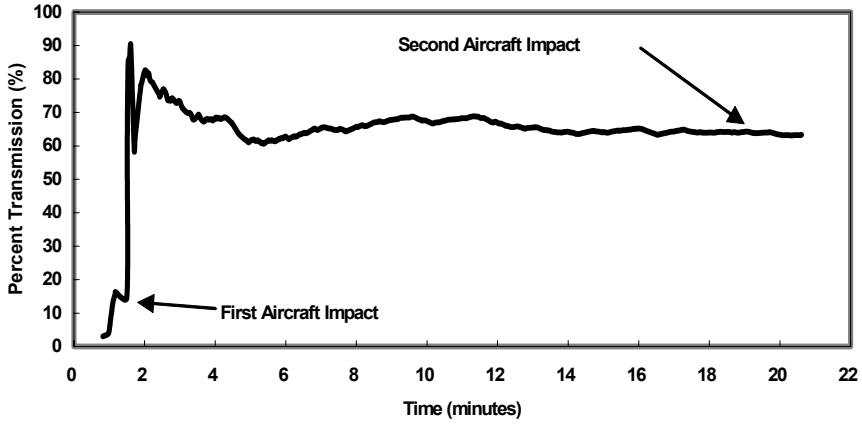


Figure P–3. NYPD Division 1 channel plot of percent transmission versus time.

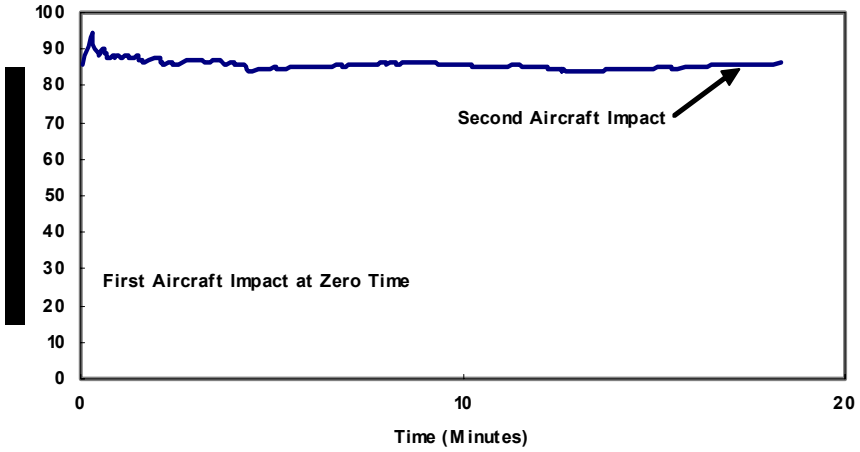
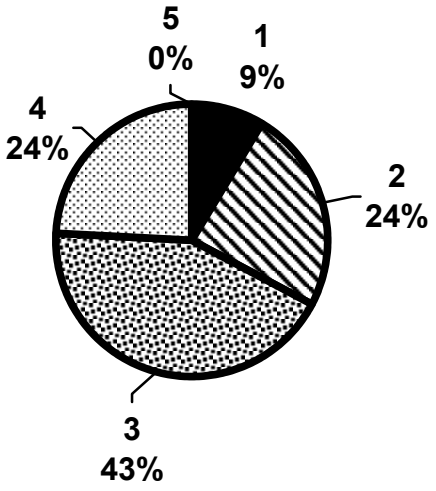


Figure P–4. NYPD Special Operations Division channel plot of percent transmission versus time.

P.7.4 Radio Communications Readability Analysis

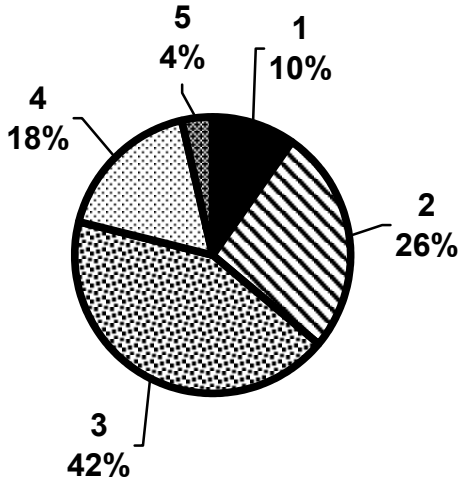
As each of the communications files was transcribed a readability value was assigned for each attempt to communicate. Results of this analysis are shown in Figs. P–5 through P–8. Analysis of these data showed that the ability to transmit a complete message was difficult during the communications surge. Data showed that approximately one-third to one-half of the radio communications for each of the three departments did not exceed a readability level of 2. These emergency communications were not complete and may have not been fully understood. The largest fraction of readability for all radio communications analyzed was recorded at a readability level of 3. This means that this fraction of communications was readable, but audio and radio transmission problems were being experienced. Some conditions that will cause poor communications quality are:

- Background noise either at the transmission point or receiving point or both,
- Operating health of transmitting and receiving radios and antenna systems,
- Doubling or crossing of radio signals caused by multiple transmissions at the same time on the same radio frequency, and
- Radio transmissions that may be affected by alternating materials or electromagnetic interference.



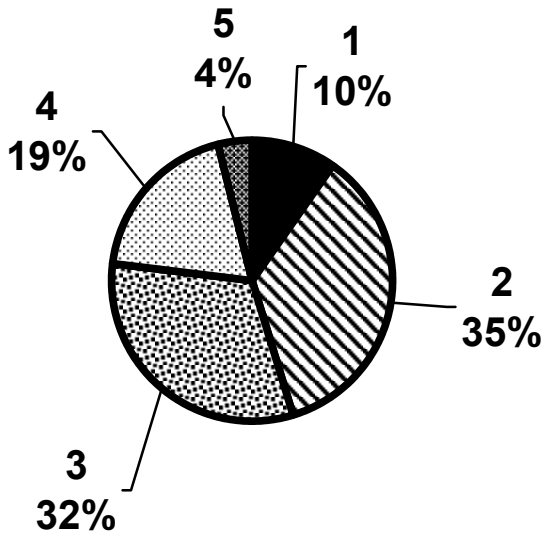
Note: Readability scale:
1 – Unreadable
2 – Barely readable, occasional words distinguishable
3 – Readable with considerable difficulty
4. – Readable with practically no difficulty
5. – Perfectly readable

Figure P–5. PAPD police desk Channel 26/W radio communications readability.



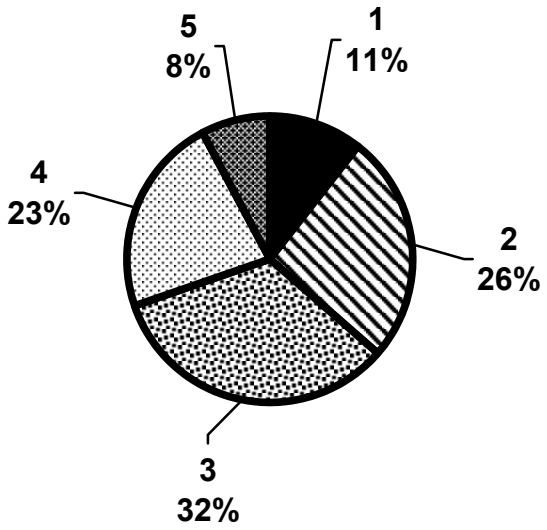
Note: Readability scale:
1 – Unreadable
2 – Barely readable, occasional words distinguishable
3 – Readable with considerable difficulty
4. – Readable with practically no difficulty
5. – Perfectly readable

Figure P–6. FDNY City-wide high-rise repeater Channel 7 at the WTC site (PAPD Channel 30), radio communications readability.



Note: Readability scale:
1 – Unreadable
2 – Barely readable, occasional words distinguishable
3 – Readable with considerable difficulty
4. – Readable with practically no difficulty
5. – Perfectly readable

Figure P–7. NYPD Special Operations Division channel radio communications readability.



Note: Readability scale:
1 – Unreadable
2 – Barely readable, occasional words distinguishable
3 – Readable with considerable difficulty
4 – Readable with practically no difficulty
5 – Perfectly readable

Figure P–8. NYPD Division 1 channel radio communications readability between FDNY personnel in the lobby of WTC 2 and FDNY personnel some 40 or more floors up inside the same building.

In addition, approximately 25 percent of the radio communications had readability levels 4 or above. Typically, the higher readability levels were produced by the various department base stations that operate at a higher radio transmission output power than the hand held radios. However, there is one exception: several of the radio communications on the FDNY City-wide high-rise radio channel, the PAPD recording of Channel 30. It appears that the repeater was operating at the WTC site. Several of the radio communications on this channel were assigned readability values of four and five as the FDNY began its operations in WTC 2. In addition, some of these 4 and 5 readability value radio communications were occurring between FDNY personnel in the lobby of WTC 2 and FDNY personnel some 40 or more floors up inside the same building.

P.7.5 Observations on Radio Communications

All of the radio systems analyzed appeared to work well during the period of normal operations before the attack on the WTC. It was noted that Channel W of the PAPD was experiencing some difficulty with a handie-talkie radio transmitting a carrier wave as a result of an open or keyed microphone, which disrupted communications on that channel. PAPD personnel recognized the problem and were busy trying to correct it just before the first plane struck WTC 1. The keyed microphone problem continued after the attack occurred. NYPD also had a problem with an open or keyed microphone after the incident began, occurring on the Special Operations Division channel. The problem was recognized and efforts were also made by the NYPD desk operator to get the problem cleared up. Initial attempts to correct the open microphone problem appeared to be successful.

Also, the data above for the various departments demonstrate the significant changes that occurred in radio communications traffic during the incident. It is evident that PAPD, FDNY, and NYPD all experienced similar surges in radio traffic volume following the first aircraft impact into WTC 1. It is also interesting to note that when the second aircraft struck WTC 2, 17 minutes later, there was no major surge in radio communications. This may be attributed to the fact that the initial emergency response assignments had already been made and that operations had already begun at the WTC, and an additional surge in radio communications was not needed. In addition, it is observed from the communications recordings and from first-person interviews that the emergency responders were trying to limit their use of the radios to reduce interference on their operating frequencies.

P.7.6 Preliminary Chronology of Emergency Communications

The following are lists of selected chronological communications messages that provide information concerning (1) dispatch and arrival of emergency response units, (2) evacuation, (3) emergency response operations, (4) emergency response communications, and (5) observations of building conditions.

Note: These chronologies are based on the best possible data provided to NIST for the analysis. The times are given to represent the exact event sequence. Based on the variations of recorded clock times for the data and times assigned for each recording provided by the departments, it is estimated that the error for time with these chronologies is likely to be on the order of ±2 minutes.

Dispatch and Arrival of Emergency Responders Chronology

This chronology clearly demonstrates that the emergency response to the World Trade Center was immediate. Within the first 3 minutes of the aircraft impact on WTC 1, PAPD was responding by providing information on the incident to the police desk, FDNY had dispatched 26 units to the incident, and NYPD had called of a department mobilization that included dispatching aviation units to the incident for visual assessment. In less than 10 minutes, PAPD had called a chemical mobilization; NYPD had dispatched five ESU teams and had two aviations units at the scene providing observations. In less than 30 minutes, 121 FDNY units had been dispatched to the scene and 30 units had signaled their arrival at the scene. This response combined with the activities undertaken demonstrates a high level of professionalism by the various departments.

8:46 a.m. FDNY Chief makes report that an airplane has struck the upper floors of a WTC building and transmits a first and second alarm.
PAPD officer reports to the police desk an explosion at the WTC.
8:48 a.m. 26 FDNY units dispatched. NYPD calls for a department mobilization.
8:49 a.m. NYPD requests for aviation to get in the air and make a visual assessment.
8:50 a.m. PAPD officer calls for a chemical mobilization.
8:52 a.m. 5 NYPD Emergency Service Units dispatched.
NYPD aviation requests landing zone in the vicinity of the WTC.
NYPD aviation unit arrives at the WTC and examines possibilities of roof rescue.
8:54 a.m. NYPD aviation advises they have two units in the air to do aerial survey.
8:59 a.m. FDNY Chief calls for all but one Rescue Squad to the WTC.
9 a.m. 66 FDNY units have been dispatched at this time.
9:03 a.m. FDNY Marine unit reports that a second plane struck WTC 2.
9:15 a.m. 121 FDNY units dispatched and 30 FDNY units signal* their arrival.
9:29 a.m. FDNY dispatcher relays that a department-wide recall has been instituted.

9:59 a.m. 171 FDNY units dispatched and 74 FDNY units signal their arrival.
10:29 a.m. 214 FDNY units dispatched and 103 FDNY units signal their arrival.
*Note: Arrival times are determined from 10–84 signals transmitted by units as they arrive at their assigned location. A 10-84 signal is sent by a firefighter from a fire department vehicle by pressing a button on the communications console.

Evacuation Chronology

The evacuation chronology exhibits a mix of responses to the incident. It provides insight into the successes and shortcomings of the evacuation from the WTC buildings and site. The first noteworthy event is that multiple orders were given by a senior PAPD police officer to evacuate the WTC buildings and the entire complex. There is no evidence that these orders were transmitted to appropriate personnel at the site to initiate the full evacuation of the complex. Data from these communications also show that the evacuation process was not always orderly and controlled. This is demonstrated by the fact that the first people jumped from WTC 1 at 8:52 a.m., only 6 minutes after the first aircraft struck WTC 1. In addition, it was reported that people were running from the PATH trains, and a report came in to the PAPD police desk from a police officer in WTC 5 stating that "I have people going crazy." However, it is a fact that most of the evacuation process from the WTC complex was orderly. This chronology also provides a view of the professionalism of the PA, PAPD, and building security personnel that held their posts in the face of life threatening conditions to assist people in the evacuation. In addition, these communications provide some basic information related to the status of people trapped in the buildings and the fact that the buildings elevators were not functioning or dangerous to use. Finally, several cases are listed where injured, elderly, or physically impaired people are not able to walk down the stairs in the building and need assistance to evacuate.

8:47 a.m. PAPD police desk receives a message to evacuate the building (WTC 1) and send people out towards WTC 5
PAPD police desk receives a message from a PAPD officer instructing employees to avoid the Concourse.
8:48 a.m. PAPD police desk receives two orders from a senior police officer calling for the evacuation of the building.
8:52 a.m. PAPD police desk receives report from police officer that people are jumping out of the windows from WTC 1.
8:53 a.m. PAPD police desk report indicates that people are running from the PATH trains.
8:55 a.m. PAPD police desk handles message calling for the evacuation of the Plaza
FDNY dispatcher relays information that people are trapped on floor 106 of WTC 1.
8:56 a.m. PATH trains are still bringing people into the WTC site.
PAPD police desk message attempts to assemble personnel at WTC 1 exits to the plaza to show people how to get out. One Port Authority person responds to the message that he cannot get over to the building exits because glass is falling all over the place.
PAPD police desk receives a radio message that they need assistance in WTC 4 because people are attempting to exit the building.
8:57 a.m. PAPD police desk: a message is sent stating, "Don't let anyone in the building evacuate to the Plaza at this time."
8:58 a.m. PAPD police desk instruction to security guards: hold your post and don't allow people into the Plaza or out onto the Courtyard.
PAPD police desk reports that people are trapped on floor 79 WTC 1.
8:59 a.m. PAPD police desk: a senior PAPD officer calls for the evacuation of WTC 1 and WTC 2.

PAPD police desk: a senior PAPD officer calls for the evacuation of the entire WTC complex, all buildings.

9 a.m. PAPD police desk: a police officer asks if building five should be evacuated and he was told to stand by.
PAPD police desk receives a report that there are people trapped inside suite 4711 of WTC 1 and can't get out.
PAPD police desk: orders were given to evacuate WTC 1, B4 level.
PAPD police desk: a Port Authority employee calls in that he is on floor 27 in the C staircase and has a man in a wheel chair and needs assistance.

9:01 a.m. PAPD police desk: a senior PAPD officer calls for the evacuation of all buildings in the WTC complex.

9:02 a.m. PAPD police desk: Port Authority person calls in reporting that he is stuck in an elevator on floor 78 of WTC 1 in car number 81A.

9:03 a.m. A second aircraft strikes WTC 2.

9:04 a.m. PAPD police desk: a call is made to evacuate everybody from the building now. Note: Building not identified.

9:05 a.m. PAPD police desk: a police officer indicates that WTC 4 is being evacuated. He is then going to WTC 5. He also reports that, "I have people going crazy."
PAPD police desk: a report comes in that Port Authority employees heard people stuck inside of some elevators and also report that they are getting them out. Note: Building and location not identified.
PAPD police desk: a call comes in to get everybody off the complex.

9:07 a.m. PAPD police desk: a report comes in that somebody is stuck in an elevator on floor 76. Note: Building not identified.

9:08 a.m. PAPD police desk report from an officer that debris is falling from WTC 2 by WTC 4 and Liberty Street, and to let the people out of WTC 4.

9:09 a.m. PAPD police desk report is received indicating that FDNY is entering elevator bank 11, 12. Note: Building not identified. Elevators 11 and 12 are shuttle elevators. Elevator 11 goes from the lobby to the 44th floor. Elevator 12 goes from the lobby to the 78th floor.

9:10 a.m. PAPD police desk receives a report that the express elevators could be in jeopardy of falling. Note: Building not identified.

9:12 a.m. PAPD police desk receives a radio report from the Command Desk in the lobby of WTC 2 that they cannot pick up the Warden phones and that they are making announcements telling people not to stay at the Warden phones. Note: This communication indicates that the Warden phones in WTC 2 were not working. Warden phones are located on each floor of the building for the use of floor wardens. They are wired for communications with the fire command desk in the building lobby.

9:14 a.m. PAPD police desk receives confirmation that no elevators are working. Note building not identified.

9:16 a.m. FDNY radio dispatcher advises a chief that there are people trapped in WTC 1 at the following locations: floor 82 east side; floor 83, room 8311; floor 103, room 103 near the corner, floor 104; and floor 106. WTC 2 at the following locations: floor 82 west side, floor 88, and floor 89.

9:17 a.m. PAPD police desk reports that four callers have made contact and need assistance on floor 106 of WTC 1.

9:20 a.m. PAPD police desk receives a message from an officer that no one is down on the B4 level of WTC 1.

9:23 a.m. FDNY radio dispatcher advises FDNY Field Communications Unit that 100 people are overcome in WTC 1 on the northwest and southwest corner of floor 103. The dispatcher also reports that Ladder 3 reports numerous injuries in the stairwell of floor 35 on up.

9:24 a.m. PAPD police desk receives a report from an officer that people from floor 64 are now coming down onto the courtyard level of WTC 1.

9:28 a.m. PAPD police desk receives a radio report of an injured person with burn injuries caused by a falling elevator. Note: Location of injured person was provided as A20. This may mean WTC 1 on floor 20 on the A stairway.

9:29 a.m. PAPD police desk reports that there is a medical emergency in the B stairway; there is a person that cannot walk down. The people are coming down from floor 51, and the person needing assistance has asthma. Note: Building not identified.

9:30 a.m. PAPD police desk receives a report that two elderly people on floor 51, B stairway, WTC 1, cannot walk down and need medical assistance.

9:37 a.m. PAPD police desk recorded the following message: "All World Trade Center units to the Command Post. All World Trade Center units escort everybody over the land bridge on West Street to the Financial Center. Do not, repeat, do not send people out into the Concourse on to south side."

9:45 a.m. PAPD police desk receives a report that officers are sending people down, evacuating on the A stairway in WTC 1.
PAPD police desk copies a request for crowd control on Broadway. Answer to the request is that the City police should be responding.

9:56 a.m. PAPD police desk receives a report that WTC 1 is not completely evacuated and that people are still coming out of each stairway.

Emergency Response Operations Chronology

This section provides a view of the emergency response operations carried out by FDNY, NYPD, and PAPD at the WTC. The chronology highlights several communications that identify cases where emergency responders are assisting injured people, call for EMS assistance, and search for functioning elevators to help evacuate injured people. Some fires in the buildings are identified and some fire fighting operations in WTC 2 are identified. Communications from PAPD provide information on the locations of many people that were trapped in the buildings and in elevators. Several communications provide insight into FDNY operations in WTC 2 and show that some fire fighters actually reached the 78th floor in WTC 2. This assent to the 78th floor was assisted by the use of an elevator that operated up until just before the building collapsed. The elevator became stuck in the elevator shaft and the firefighter operating the elevator was chopping his way out when the building collapsed. Several radio communications provide insight into the difficulty that emergency responders had trying to climb the stairs of the WTC. Cases are noted where FDNY personnel had to stop and rest. Radio communications for the FDNY channel 7 repeater also point out the difficulty that some firefighters had with the identification of the two buildings. The exchange of communications by FDNY personnel at 9:29 a.m. clearly shows this difficulty. Several communications from NYPD aviation units show how the aircrews repeatedly accessed the possibility of landing on the roof of WTC 1 and reported that conditions were not safe for landing. However, at 9:38 and 9:40 a.m. an aviation unit calls in for permission to land on the roof of WTC 1. No evidence has been found that indicates that people were seen on the tower roof or that conditions had improved when these radio requests were made. Interviews with aviation personnel indicate that many of them were highly troubled by the number of occupants trapped in the buildings and the number of people jumping from the buildings, and they were distressed that they were unable to help them. At 9:43 a.m. the order came from a senior police department official that no one from the aviation units is to rappel on the building's roofs. Communications in this section also provides information that many people were coming to the WTC to volunteer their assistance. This assistance was turned away as the emergency responders felt that they needed to get everybody away from the WTC complex.

8:46 a.m. An aircraft strikes WTC 1.

8:49 a.m. PAPD police desk a message is received that Emergency Medical Service (EMS) is needed because there is an injured security guard. The message was not complete; the location was not understandable.

8:50 a.m. FDNY establishes a command post in the lobby of WTC 1.
PAPD police desk message from an officer on the B2 level of WTC 1 that there are two workers injured on that level and that EMS is needed ASAP.
PAPD police desk receives a radio call from FDNY Ladder 10 requesting information from PAPD about which building was struck and the location of the fire, WTC 1 or WTC 2.
FDNY uses a Port Authority Radio for the communication.

8:52 a.m. NYPD aviation unit arrives at the WTC to examine possibilities for roof rescue.

8:56 a.m. PAPD police desk recording: an officer calls for an ambulance at WTC 4 for an injured person.

8:58 a.m. NYPD aviation unit advises that they are unable to land on the roof due to heavy smoke conditions.

9 a.m. PAPD police desk receives a message that there is an injured person between floors 14 and 15 of WTC 2.

9:01 a.m. PAPD police desk receives a report of a fire in a parking lot.

9:02 a.m. PAPD police desk receives a report of a gas leak. (Incomplete message, location of leak not identified.)

9:03 a.m. An aircraft strikes WTC 2.

9:03 a.m. PAPD – by this time a PAPD senior officer has called three times for the evacuation of the World Trade Center, WTC 1 and WTC 2, and then "all buildings in the complex."

9:03 a.m. PAPD police desk reports that another aircraft has stuck WTC 2.

9:05 a.m. PAPD police desk, an officer calls in and requests that every ambulance that can be spared be sent to the WTC.

9:10 a.m. FDNY dispatcher receives message that people are trapped on floor 86 of WTC 2.

9:11 a.m. FDNY reports that Engine 10 requests that all responding units stop short of the WTC buildings, either north or south of Liberty and West Street because of the large number of parked ambulances and debris falling from the buildings.

9:17 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30) indicates that they are using an elevator for operations in WTC 2.

9:18 a.m. FDNY radio communication from WTC 2 indicates they have one elevator working to floor 40, and it is staffed by a firefighter from Ladder 15.
PAPD police desk receives a report that FDNY is abandoning its command post and going across the street.

9:22 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30) states that a Battalion Chief is on floor 43 or WTC 2 in the B stairway.
FDNY Battalion Chief now located on floor 43 of WTC 2 receives a message from a FDNY member in the lobby that NYPD Emergency Service police officers (Emergency Service Unit) want to provide support for him. The Battalion Chief gives the Emergency Service Unit police officers direction to his location on floor 43 in the B stairway.

9:26 a.m. NYPD aviation unit advises that it is impossible to land on the roof at this time.

9:29 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): a Battalion Chief is communicating that he is located inside "Tower 2, the South Tower." A firefighter follows the communication attempting to correct the Chief by saying that he was actually in the "North Tower, Tower 2." This communication confused the actual location of the Battalion Chief, who later came back on the radio reporting that he was in the South Tower. Interviews with FDNY personnel conclusively show that the Battalion Chief was actually inside WTC 2, the South Tower.

9:30 a.m. PAPD police desk receives a report that EMS is setting up a triage station in the lobby of WTC 2.

9:32 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): firefighters have been able to get to floor 55 inside WTC 2.

9:38 a.m. NYPD aviation unit calls in to request a landing on the roof of the North Tower as soon as possible.

9:39 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): FDNY officer inside WTC 2 indicates that he is sending 10 to 15 injured people down to floor 40 and that the firefighter at that location should take the injured to the building's lobby in the elevator. The officer also requests that the firefighter operating the elevator bring an EMS crew back up with him.

9:40 a.m. NYPD officer advises that they need the aviation units on the roof as soon as possible.

9:41 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): Hazmat 1 reports that they are on floor 48 of WTC 2 in the B stairway.

9:42 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30) a firefighter informs the Battalion Chief that he cannot find any elevator banks that are operating above floor 40. The Chief advises the firefighter that he should climb the B stairway from his location.

PAPD police desk receives a report that people have arrived and want to volunteer to help and where should they be sent. Answer: "Right now just send everybody away from the World Trade. We are not letting anybody come close to it."

PAPD police desk receives a radio report that a triage center has been set up at WTC 4 at Victoria's Secret.

9:43 a.m. NYPD officer advises that no one is to rappel onto the top of the buildings.

Note: The term "rappel" in this case refers to the process of emergency responders using ropes suspended from a helicopter to descend onto the roof of a building.

9:44 a.m. PAPD police desk receives a communication that "They haven't evacuated the Fire Command over here in building 2 or 1."

9:45 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): a firefighter calls the Battalion Chief and reports that they had to take their coats off.

9:49 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): Battalion Chief instructs firefighter that it is imperative that he get down to the lobby command post to get some people up to floor 40. Injured people are being sent down from floor 70. The firefighter is inside an operating elevator and is reporting that it is not operating properly and expresses concerns about the elevator becoming stuck in the shaft.

9:50 a.m. PAPD police desk receives a message that FDNY needs a resuscitator on floor 19, B corridor of WTC 1.

9:54 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): a Battalion Chief calls for a ladder company in the A stairway to extinguish two fires. They are attempting to stretch building hose lines on about floor 78.

FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): a firefighter calls to the Battalion Chief that he is on floor 55 and must stop to rest.

PAPD police desk message indicates that an officer is located on floor 22, fire command center and that there is heavy traffic in the B stairway. The person indicates that they cannot release any emergency locked doors due to fire and the loss of electrical power.

Note: Communication appears to originate from WTC 1.

PAPD police desk receives a report that there are 18 passengers stuck in an elevator on floor 78 sky lobby of WTC 2 and that firefighters are working to get them out. They request EMS at the location on the double.

9:56 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): inside WTC 2, a firefighter states they are in the B stairway and that they will have to put some fire out in order to get to the A stairway.

9:57 a.m. PAPD police desk receives reports by radio on Channel X and by phone at 435-2131 from floor 78 of WTC 2 that people are coming out of the elevator banks.
At and below floor 79 of WTC 2, FDNY, NYPD, and PAPD personnel are evacuating occupants, assisting the injured, and fighting fires.
FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): a firefighter in WTC 2 reports that he is trapped in an elevator in the elevator shaft and that they are chopping their way out.

9:59 a.m. FDNY Marine unit reports the collapse of WTC 2.

10:28 a.m. FDNY Marine unit advises that the second WTC tower collapsed.

Emergency Response Communications Chronology

This chronology provides information on communications difficulties experienced by NYPD and PAPD following the attack on the WTC. Much has been published concerning the communications difficulties experienced by FDNY during the incident, and first person interviews with FDNY personnel confirms some of these difficulties. However as shown by this chronology, FDNY was not the only emergency responder department that experienced radio equipment and communications difficulties. There are reports of radios not working well and communications showing that some personnel were not being heard or responded to. Also, some of the radio transmissions demonstrate the failure to communicate as a result of radio traffic surge conditions.

The chronology provides examples of numerous cases where radio transmissions were not understood because of "crossing or doubling" of radio signals when too many people are trying to talk at one time.

8:45 a.m. PAPD police desk Channel W: requests a radio check to locate an open microphone on a handie-talkie radio.

8:49 a.m. PAPD police desk requests, as a result of the surge in radio traffic volume, that police officers stay off the air.
PAPD police desk Channel W: extended period with an open microphone, lots of background noise and people talking.

8:50 a.m. PAPD police desk receives a message that the officer did not copy the previous transmission and asks what is going on.

8:51 a.m. NYPD Special Operations Division channel: a dispatcher advises a police lieutenant that his message was crossed and to repeat it. A message came through that he can't get ahold of someone on the cell phone.

8:53 a.m. NYPD Special Operations Division channel: a dispatcher advises a police department truck that their radio message is cutting off and all that the dispatcher got was something about the upper floors.

8:54 a.m. PAPD police desk is reporting that it is having trouble reading incoming radio transmissions.
PAPD police desk receives a message that an officer is having trouble reading radio messages because of so much commotion on the floor.

8:59 a.m. NYPD Special Operations Division channel: a dispatcher advises a police truck that their radio message is breaking up, and the dispatcher asks what units he wants to respond.

9 a.m. NYPD Special Operations Division channel: dispatcher advises that various units are crossing each other and that the dispatcher cannot understand them.

9:01 a.m. PAPD police desk Channel Y: a microphone is stuck open, interfering with communications.

9:02 a.m. NYPD Special Operations Division channel: a police officer asks the dispatcher if the last transmission was heard. The police office asks twice. There is no answer.

9:03 a.m. PAPD police desk receives a report that someone has found a supervisor's radio that has been lost.

NYPD Special Operations Division channel: an officer in an NYPD car requests that units give their messages slowly.

9:05 a.m. FDNY chief officers conduct tests of the City-wide, high-rise repeater located at the WTC.

9:07 a.m. NYPD Special Operations Division channel: a police officer requests that the air be cleared for emergency vehicles and personnel unimpeded.

9:08 a.m. NYPD Special Operations Division channel: a dispatcher advises officers directing traffic that they are coming over the air. Approximately 30 s later the dispatcher advises a second time that the officers directing traffic are coming over the air and requests that they stop.

9:09 a.m. NYPD Special Operations Division channel: a Special Operations Division officer requests that the dispatcher designate two channels for this emergency, one for units on the scene and one for units that are responding.

9:11 a.m. NYPD: a backup transmitter for City-wide communications is put into service in anticipation of potential problems with the primary transmitter.

9:12 a.m. NYPD City-wide channel: a dispatcher advises that "We need to keep this frequency clear unless it is in regards to the level four mobilization."

NYPD Special Operations Division channel: dispatcher state "Only emergency transmissions are to be made on this frequency."

FDNY Chief begins using the FDNY channel 7 repeater while working inside WTC 2.

PAPD police desk receives a radio report from the Fire Command Desk in the lobby of WTC 2 that they cannot pick up the Warden phones and that they are making announcements telling people not to stay at the Warden phones. Note: This communication indicates that the Warden phones in WTC 2 were not working.

9:15 a.m. PAPD police desk Channel W: a radio microphone is stuck open.

9:19 a.m. NYPD Special Operations Division channel: a dispatcher advises a police officer that his message was being cut off and that only part of the message was copied.

9:20 a.m. NYPD Special Operations Division channel: a dispatcher advises that there is an open carrier and the units should check their radios.

9:22 a.m. NYPD Special Operations Division channel: a dispatcher advises a police truck that his radio message was unreadable.

NYPD Special Operations Division channel: the dispatcher advises a second time that there is an open carrier and that messages are not being understood.

9:23 a.m. NYPD Special Operations Division channel: the dispatcher advises that the two frequencies are the Manhattan IO (Interoperability Channel) and the City-wide. The dispatcher also advises that the various units are crossing.

9:25 a.m. PAPD police desk Channel W: a radio microphone is stuck open and interfering with communications. Radio signals are garbled and broken, and there is a high level of background noise.

9:30 a.m. PAPD police desk Channel X has a communication indicating that everybody should turn their phone off.

9:31 a.m. PAPD police desk Channel X: a Port Authority officer is questioned as to whether they have brought any red bags with radios for the fire department. The answer is no, and is it safe to go into the building.

9:32 a.m. NYPD City-wide channel: a unit advises that he cannot communicate, his radio is going in and out and the cell phone is not working.

9:36 a.m. NYPD Special Operations Division channel: a police officer reports that the telephones at his location are not working. Note: Location not identified.

9:43 a.m. NYPD Special Operations Division channel: a police officer advises that he heard over an AM radio that a plane had crashed into the Pentagon.
9:49 a.m. PAPD police desk instructs officer that he was speaking too fast and that he must slow down so that he could be understood.
9:53 a.m. NYPD Special Operations Division channel: the dispatcher advises all units to check their portable radios for an open carrier.
9:54 a.m. NYPD City-wide channel: a dispatcher requests "Keep the air clear. We have problems in the City. Keep the air clear right now."
9:55 a.m. PAPD police desk Channel Z: police officers are having trouble reading communications over the radio and indicate that they will try to call on the telephone.
9:57 a.m. PAPD police desk Channel X: a report is received that an officer is responding to WTC 1 Fire Command and that he had been trying to contact the Command Center on floor 22, but they didn't know how to operate the other set of communications equipment.
9:59 a.m. NYPD Special Operations Division channel: an Emergency Service Unit police officer calls several times for the dispatcher. The dispatcher answers each time and apparently was not heard by the calling unit.
10:03 a.m. NYPD Special Operations Division channel: a dispatcher requests that some units standby while the needs of other units are addressed.
10:05 a.m. NYPD Special Operations Division channel: the dispatcher advises that all units need to talk one by one. The dispatcher further advises that units are cutting each other off.
10:09 a.m. NYPD Special Operations Division channel: an Emergency Service Unit advises the dispatcher that he can hear the dispatcher but is not sure if the dispatcher is hearing him.
10:10 a.m. NYPD Special Operations Division channel: the dispatcher advises that there are three units trying to talk at the same time and requests, "One at a time."

Condition of the WTC Towers Chronology

Information provided by this chronology partially describes the variable conditions found in WTC 1 and WTC 2 towers. It is shown that the impact of the first aircraft into WTC 1 produced an explosive condition all the way down to the building's basement. The impact of the aircraft into what appears to be WTC 2 produced jet fuel fires in the building on the 51st floor. Other communications indicate that there was no smoke or fire on the 68th, 73rd, or 74th floors, the walls in stairway B had been breached. A telephone call to a New York City Radio 9-1-1 telephone operator at 9:36 a.m. indicates that a floor in the 90's level of WTC 2 had collapsed. Information from this call concerning the floor collapse appears to be misstated by the NYPD Division 1 radio operator in the message transmitted at 9:41 a.m. and again at 9:51 a.m. Communications from the NYPD aviations units describe a steady deterioration of the two WTC towers before they collapsed.

8:47 a.m. PAPD police desk reports that there is a fire on floor 22 of WTC 1.
PAPD police desk receives a report that there is a lot of debris on floor 22 of WTC 1.
8:49 a.m. PAPD police desk reports that there is damage and a lot of debris on floor 22 of WTC 1.
8:51 a.m. PAPD police desk receives a call that an explosion was observed in the basement of the B1 level of WTC 1. The police desk informs the officer on the B1 level that what he saw resulted from an explosion on the upper floors of the building.
8:57 a.m. PAPD police desk receives report that water pipes are broken on the B4 level of WTC 1.
9:02 a.m. PAPD police desk receives message from a person trapped in an elevator on floor 78 of WTC 1 that the area has smoke, and water and debris are coming down from above.
9:10 a.m. PAPD police desk receives a report that there is burning jet fuel on floor 51 of one of the towers. Note: Communications suggest this is WTC 2.
9:13 a.m. PAPD police desk receives a report that WTC 1 is flooding.

9:32 a.m. PAPD police desk receives a message from an officer that the WTC Concourse is flooding.
9:36 a.m. New York City 9-1-1 telephone operator receives a message from an occupant of WTC 2 that a floor had collapsed below them in the 90's level.
9:41 a.m. NYPD dispatcher advises units that floor 106 in WTC 2 is collapsing and that the message comes from someone on that floor.
9:47 a.m. FDNY radio communications on the City-wide, high-rise Channel 7 (PAPD Channel 30): a firefighter inside WTC 2 reports that he is standing in the B stairway on floor 74 and there is no smoke or fire problem. He reports that the stairway walls have been breached on floors 73 and 74. Another FDNY unit in the same stairway reports that the walls were also breached on floor 68.
9:49 a.m. NYPD aviation unit gives a radio report stating that "large pieces" are falling from WTC 2.
9:51 a.m. NYPD dispatcher advises that at WTC 2, floor 106 is crumbling per communications with victims trapped on the floor.
9:58 a.m. NYPD aviation unit advises that the south tower is coming down.
10:06 a.m. NYPD officer advises that it isn't going to take much longer before the north tower comes down and to pull emergency vehicles back from the building.
10:20 a.m. NYPD aviation unit reports that the top of the tower might be leaning.
10:21 a.m. NYPD aviation unit reports that the north tower is buckling on the southwest corner and leaning to the south.
NYPD officer advises that all personnel close to the building pull back three blocks in every direction.
10:27 a.m. NYPD aviation unit reports that the roof is going to come down very shortly.
10:28 a.m. NYPD officer reports that the tower is collapsing.

P.8 FINDINGS

The following is a list of preliminary findings based on the current status of emergency responder communications analysis:

1. After the first aircraft struck the WTC, there was a peak increase in emergency responder radio communications by approximately a factor of 5, followed by an approximate factor of 3 steady level of radio communications.

2. A surge in communications traffic volume made it more difficult to handle the flow of communications and delivery of information.

3. Analysis of the radio communications records received by NIST indicates that roughly one-third to one-half of the radio messages transmitted during these radio traffic surge conditions were not complete messages nor understandable.

4. Preliminary analysis of the FDNY City-wide, high-rise Channel 7 (PAPD Channel 30) recording indicates that the WTC site repeater was operating.

5. Communications records and interviews indicate that smoke and heat conditions on the top of the two WTC buildings prevented the NYPD helicopters from conducting safe roof evacuation operations.

6. NYPD aviation unit personnel reported critical information about the impending collapse of the WTC towers several minutes prior to their collapse. No evidence has been found to

suggest that the information was further communicated to all emergency responders at the scene.

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Attachment 1
COMMUNICATIONS OF THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY

The National Institute of Standards and Technology received duplicates of many radio and telephone channels. The tapes listed below cover a wide range of times. All recordings cover at least from 0845 to 0958. The remainder of the communications can be placed in two categories as follows: 0705 to 0958 and 0705 to 1800.

Central Police Desk (CPD): Police Command Channel 2 to 39 – Each one of these recordings is 198 minutes long.

CPD Ch. 002 – CPD.wav – Not assigned
CPD Ch. 003 – CPD.wav – Not assigned
CPD Ch. 004 – CPD.wav – Not assigned
CPD Ch. 005 – CPD.wav – Not assigned
CPD Ch. 006 – CPD.wav – Not assigned
CPD Ch. 007 – CPD.wav – Not assigned
CPD Ch. 008 – CPD.wav – Not assigned
CPD Ch. 009 – CPD.wav – Not assigned
CPD Ch. 010 – CPD.wav – Not assigned
CPD Ch. 011 – CPD.wav – Not assigned
CPD Ch. 012 – CPD.wav – Not assigned
CPD Ch. 013 – CPD.wav – Not assigned
CPD Ch. 014 – CPD.wav – Not assigned
CPD Ch. 015 – SPEN 1 State Police Emergency Network.wma
CPD Ch. 016 – Radio SPEN 2 State Police Emergency Network.wma
CPD Ch. 017 – Radio (Ch. A) PA Area Wide.wma
CPD Ch. 018 – Radio (Ch. W) LT Police.wma
CPD Ch. 019 – CPD.wav – Not assigned
CPD Ch. 020 – CPD.wav – Not assigned
CPD Ch. 021 – Phone 9-1-1 Emergency.wma (Note: Recording was blank.)
CPD Ch. 022 – Phone 9-1-1 Emergency.wma (Note: Recording was blank.)
CPD Ch. 023 – Phone SGT's Desk - 201-216-6800.wma
CPD Ch. 024 – Phone Clerk - 201-216-6800.wma
CPD Ch. 025 – Phone TTY NY- 201-216-6800.wma
CPD Ch. 026 – Phone Clerk Extra - 201-216-6800.wma
CPD Ch. 027 – Phone TTY NJ - 201-216-6800.wma
CPD Ch. 028 – Phone Absence Control Line 1 - 201-216-6988.wma
CPD Ch. 029 – Phone Absence Control Line 2 - 201-133-6988.wma
CPD Ch. 030 – Phone 800 number SGT's Desk - 201-216-6858.wma
CPD Ch. 031 – Desk TTY number 3.wma
CPD Ch. 032 – CPD.wav – Not assigned
CPD Ch. 033 – CPD.wav – Not assigned
CPD Ch. 034 – CPD.wav – Not assigned
CPD Ch. 035 – Phone 201-963-7247 Assignment Line 800-776-8580.wma

CPD Ch. 036 – Phone 201-963-7248 Assignment Line 800-776-8580.wma
CPD Ch. 037 – Phone 201-963-7249 Assignment Line 800-776-8580.wma
CPD Ch. 038 – Phone 201-659-3028 Toll Rob 800-TOLL-ROB.wma
CPD Ch. 039 – Phone 201-216-6794 Drug Tip 800-828-PAPD.wma

PATH Police Command: Ch. 02 to 31 – Recordings vary in length from 106 minutes to 193 minutes.

PATH Ch. 02 – Phone Desk Right.wma
PATH Ch. 03
PATH Ch. 04
PATH Ch. 05
PATH Ch. 06 – SGT. desk.wma
PATH Ch. 07 – Tour Commander.wma
PATH Ch. 08 – Report Room.wma
PATH Ch. 09 – Juvenile Room.wma
PATH Ch. 10 – Reserve Room 216-6078.wma
PATH Ch. 11 – Phone Desk Left.wma
PATH Ch. 12 – Jersey City Fire Department.wma
PATH Ch. 13 – Jersey City Medical Center.wma
PATH Ch. 14 – Jersey City Police.wma
PATH Ch. 15 – NYPD.wma
PATH Ch. 16
PATH Ch. 17
PATH Ch. 18
PATH Ch. 19 – Conference Room 1.wma
PATH Ch. 20 – Conference Room 2.wma
PATH Ch. 21 – Radio (R2) Train Master.wma
PATH Ch. 22 – PD Wall (Desk Area).wma
PATH Ch. 23 – Court Office 1.wma
PATH Ch. 24 – Court Office 2.wma
PATH Ch. 25 – Court Sgt.wma
PATH Ch. 26 – Radio (R1) Train Master.wma
PATH Ch. 27 – Radio (R30) Communications.wma
PATH Ch. 28
PATH Ch. 29
PATH Ch. 30
PATH Ch. 31

WTC Police Desk 1: Ch. 002 to 039 – Each one of these recordings is 171 min.

Ch. 002 WTC.wav
Ch. 003 WTC.wav
Ch. 004 WTC.wav
Ch. 005 WTC phone 435-8456 clerk.wav
Ch. 006 WTC phone 435-8462 clerk.wav
Ch. 007 WTC phone 435-2135 TC.wav
Ch. 008 WTC phone 435-3541 desk left.wav
Ch. 009 WTC phone 435-3541 desk center.wav
Ch. 010 WTC phone 435-3541 desk right.wav
Ch. 011WTC phone 435-8460 conf. room.wav
Ch. 012WTC .wav

Ch. 013 WTC phone 435-3519 office.wav
Ch. 014 WTC direct line FDNY.wav
Ch. 015 WTC direct line NYC EMS.wav
Ch. 016 WTC phone 435-7666 floor warden.wav
Ch. 017 WTC direct line fire command WTC 1.wav
Ch. 018 WTC direct line fire command WTC 2.wav
Ch. 019 WTC.wav
Ch. 020 WTC.wav
Ch. 021 WTC phone 435-2133 police reserve rm.wav
Ch. 022 WTC phone 435-2131 SHO desk.wav
Ch. 023 WTC phone 435-2948 desk.wav
Ch. 024 WTC radio Ch. A.wav
Ch. 025 WTC radio Ch. B.wav
Ch. 026 WTC radio Ch. W.wav
Ch. 027 WTC radio Ch. X.wav
Ch. 028 WTC radio Ch. Y.wav
Ch. 029 WTC radio Ch. Z.wav
Ch. 030 WTC FDNY radio.wav
Ch. 031 WTC.wav
Ch. 032 WTC.wav
Ch. 033 WTC.wav
Ch. 034 WTC.wav
Ch. 035 WTC.wav
Ch. 036 WTC.wav
Ch. 037 WTC.wav
Ch. 038 WTC.wav
Ch. 039 WTC.wav

Newark International Airport: Police Command – Ch. 02 to 39

EWR Ch. 002
EWR Ch. 003
EWR Ch. 004
EWR Ch. 005
EWR Ch. 006
EWR Ch. 007
EWR Ch. 008 – Phone 733-7525 – Newark PD.wma
EWR Ch. 009 – Phone PL234846 – Eliz. PD.wma
EWR Ch. 010 – Phone PL92866- Newark FD.wma
EWR Ch. 011 – PL234881 – Eliz. FD.wma
EWR Ch. 012 – Phone PL230333 – AFA.wma
EWR Ch. 013
EWR Ch. 014 – Phone PL234979 – REMCS.wma
EWR Ch. 015 – FAA Tower Crash Alarm.wma
EWR Ch. 016
EWR Ch. 017
EWR Ch. 018 – PNPD PVL - OSNA660-650.wma
EWR Ch. 019 – Phone 589-6321 - PNPD.wma
EWR Ch. 020 – Phone 589-0292 - PNPD.wma
EWR Ch. 021 – Phone 961-6666 - Line 3.wma
EWR Ch. 022 – Phone 961-6666 - Line 4.wma

EWR Ch. 023 – Radio – EWR Command – 800Mhz.wma
EWR Ch. 024 – Radio – EWR ARFF – 800Mhz.wma
EWR Ch. 025 – Radio – EWR TAC 1 - 800Mhz.wma
EWR Ch. 026 – Radio – Central police desk - 800Mhz.wma
EWR Ch. 027 – Radio – EWR Detectives.wma
EWR Ch. 028 – Police desk left phone – 961-6230.wma
EWR Ch. 029 – Police desk phone center – 961-6230.wma
EWR Ch. 030 – Police CAD desk phone – 961-6230.wma
EWR Ch. 031 – Police desk right phone – 961-6230.wma
EWR Ch. 032 – Phone 961-6666 – Line 2.wma
EWR Ch. 033 – Phone 961-6666 – Line 1.wma
EWR Ch. 034
EWR Ch. 035
EWR Ch. 036 – Radio Ch. Z – Operations & Terminals.wma
EWR Ch. 037
EWR Ch. 038 – Radio – Ch. X – Facility maintenance.wma
EWR Ch. 039 – Radio – Ch. B – Maintenance.wma

NYPD WTC Communications:

NYPD Special Operations Division
Tape 1, 08:46 – 09:33
Tape 2, 09:32 – 10:18
Tape 3, 10:18 – 11:04

NYPD City-wide 1 radio, Tape 4, 08:40 – 09:27
Tape 4b, 09:27 – 10:12
Tape 5c, 10:12 – 11.59
Tape 5d, 10:59 – 11:46

NYPD Division 1, Tape 6, 08:45 – 9:30
Tape 7, 09:29 – 10:15
Tape 8, 10:14 – 11:00